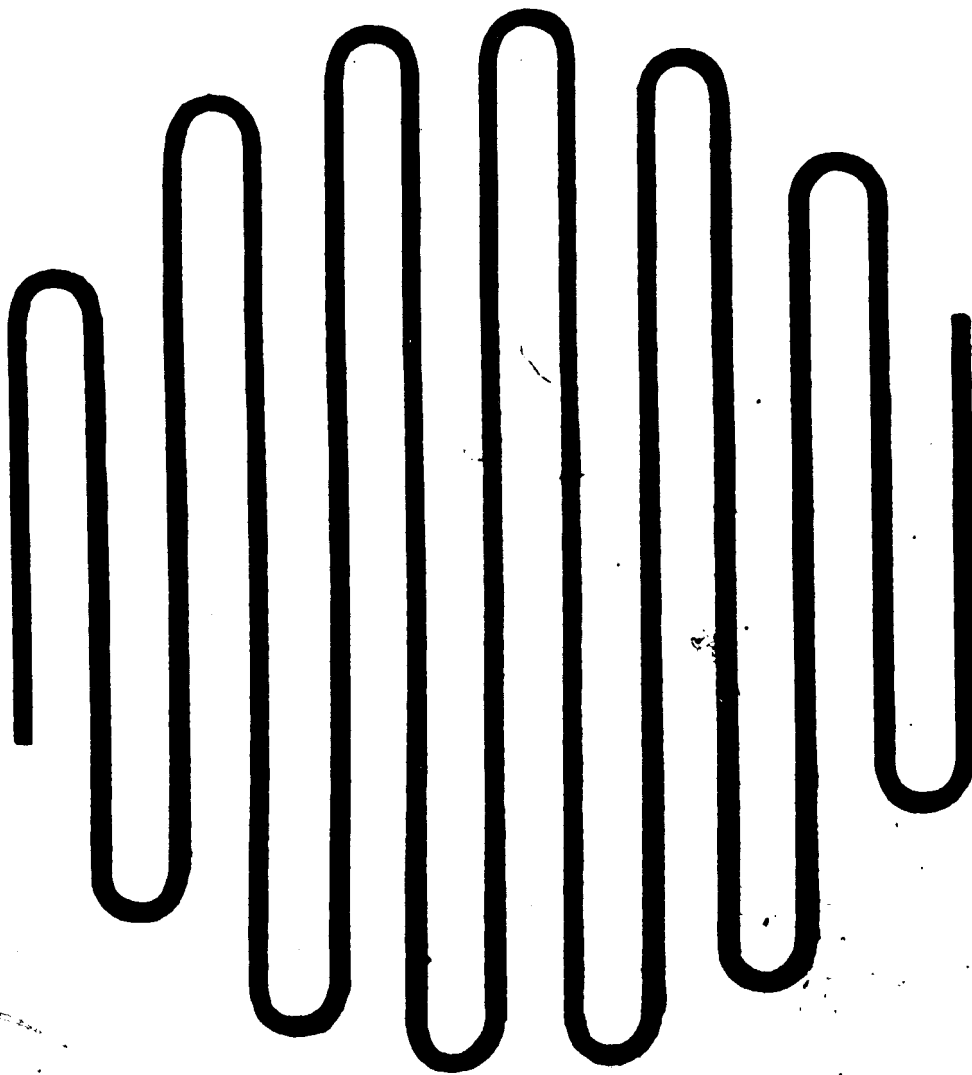


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HIGH RESISTIVITY ALLOYS

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HIGH RESISTIVITY ALLOYS



VSESOJUZNOJE IMPORTNO-EXPORTNOJE OBJEDINENIE
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This catalogue presents a line of high electrical resistance strip and wire manufactured in the USSR from alloys of high-ohmic resistance by hot-rolling and cold-rolling, and also by drawing and flattening.

High-ohmic resistance alloys are available in the following grades:

- a) X15H60, X20H80, X20H80T and X20H80T3
(of the nickel-chromium type)
- b) X13Al, OX17Al5, 1X17Al5, OX25Al5 and 1X25Al5
(of the chrome-aluminium type)

These alloys are used for the manufacture of strip (USSR Standard ГОСТ 2615-54), and round wire (USSR Standard ГОСТ 2238-53) intended for the production of high-ohmic resistances designed for use as heating elements in industrial and laboratory electric furnaces, and also in household appliances and various other electric furnaces in which the working temperature of the strip or wire wound element is within a range of from 800 to 1200 °C, depending upon the grade of alloy used.

STRIP AND WIRE FROM HIGH-OHMIC RESISTANCE ALLOYS

Strip and wire intended for the manufacture of heating and resistive elements are made of heat resistant alloys which conform to the USSR Standards GOST 5632-51 and GOST 2238-53 as to grade and chemical composition (see Table 1).

Table 1

	Chemical Composition, %										Recommended working temperature, °C					
	Carbon	Silicon	Manganese	Chromium	Nickel	Titanium	Iron	Copper	Aluminium	Sulphur	Phosphorus	Temperature, °C				
	maximum										maximum	Optimum	Maximum			
X15H60	0.15	1.0	1.5	15	18	55	61	Re- main- der		0.025	0.035	850	900	1000		
X26H80	0.15	0.50	1.5	20	23	75	78	..		0.025	0.030	950	1000	1100		
X20H80T	0.12	0.8	0.7	19	23	mini- mum 75	0.4	..	up to 0.2	up to 0.2	0.015	0.020	950	1000	1100	
X20H86T3	0.08	1.0	0.5	19	23	Re- main- der	2.0	2.9 maxi- mum 2.5	up to 2.0	0.4	1.1	0.015	0.020	950	1000	1150
X13H4	0.15	1.0	0.70	12	15	up to 0.6	0.5			3.5	5.5	0.030	0.035	650	750	850
1X17H5	0.12	1.2	0.70	16	19	up to 0.6	0.5			4.0	6.0	0.030	0.035	750	850	900
0X17H5	0.06	0.6	0.70	16	19	up to 0.6	0.5			4.0	6.0	0.030	0.035	850	950	1000
1X25H5	0.12	1.2	0.70	23	27	up to 0.6	0.5			4.5	6.5	0.030	0.035	900	1000	1150
0X25H5	0.06	0.6	0.70	23	27	up to 0.6	0.5			4.5	6.5	0.030	0.035	950	1100	1200



STRIP

High-ohmic resistance strip is manufactured hot-rolled ("H"), cold-rolled ("X"), and flattened from round wire ("F"). As to condition of the edges, hot-rolled strip is furnished with untrimmed edges, while cold-rolled strip is furnished with trimmed edges. Strip manufactured by the flattening of a round wire, on special agreement between the parties concerned, may be furnished in widths less than 6 mm and thicknesses less than 0.2 mm.

Hot-rolled strip is available in the dimensions listed in Table 2.

Table 2

Thickness, mm		Width, mm				
Normal	Permissible Variations	10	20	40	60	100
3.5	0.15					
4.0	0.20					

Permissible Variations in Width for Hot-Rolled Strip

Table 3

Thickness of Strip, mm	Permissible Variations in Width, mm	
	For Strip 10, 20 and 40 mm Wide	For Strip 60, 70, 80 and 100 mm Wide
3.5	0.8	1.5
4.0	1.0	2.0

Cold-rolled strip is available in the dimensions (in mm) listed in Table 4.

Table 4

Thickness of Strip, mm	Permissible Variations in Thickness, mm	Strip Width, mm															
		6	8	10	12	14	16	18	20	25	32	36	40	45	50	60	100
0.20; 0.22; 0.25	± 0.01	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
0.28; 0.30																	
0.32; 0.35	± 0.015		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
0.36; 0.40																	
0.45; 0.50																	
0.55; 0.60	± 0.020		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
0.70																	
0.80; 0.90		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
1.00	± 0.025	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•

Thickness of Strip, mm	Permissible Variations in Thickness, mm	Strip Width, mm																	
		6	8	10	12	14	16	18	20	25	30	35	40	45	50	60	80	100	
1.10; 1.20	± 0.030																		
1.40; 1.50	± 0.040																		
1.60; 1.80																			
2.00	0.05																		
2.20																			
2.50; 2.80																			
3.00; 3.20	± 0.05																		

Permissible Variations in Width for Cold-Rolled Strip

Table 5

Width of Strip, mm	Permissible Variations, mm
from 0.20 to 0.50 incl.	0.2
over 0.50 to 1.0 incl.	0.3
over 1.00	0.4

On mutual agreement of the parties concerned, the strip may also be furnished 120, 160, 200 and 250 mm wide.

Strip of thickness ranging from 2.0 to 3.2 mm and in widths of 80 and 100 mm is manufactured of X15H60 grade alloy.

The strip is shipped by the manufacturer in the annealed condition and with a smooth, even surface finish free from skin, cracks, hairlines and laps. The surface of the strip can be dark in colour, exhibit temper colouring, but shall be free from scale.

The edges of the strip are to be even; any unevenness of depth over one half of the permissible variations in width shall not be allowed; burrs are not allowed to exceed dimensions greater than the permissible variations in strip thickness.

Fissures on the edges of hot-rolled strip shall be of such dimensions that the width of the strip is not carried out of permissible variations in width.

Bow warp of cold-rolled strip shall not exceed 3 mm per linear metre.

The strip, when manufactured, is subjected to tension test and to 180-degree bend tests on mandrels of corresponding size. Chromium-aluminum alloy strip of 2 mm and over thickness is bend tested at a temperature ranging from 100 to 300 °C. No signs of cracking or lamination shall be discovered at the line of bending.

The electrical specific resistance and per cent elongation of cold-rolled strip shall conform to the requirements, depending upon the grade of the alloy, prescribed in Table 1.



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 Strip subjected to temperatures within limits of the specified temperature range is guaranteed to have a life of at least 60000 hours of service.

The temperature coefficients of electrical resistance (for degrees C) of these alloys are equal to $(\times 10^{-5})$:

for grade N15H60	14	for grade 1X17m5	6
" " N20H80	8.5	" " 0X17m5	6
" " N20H80T3	4	" " 1X25m5	5
" " N13m4	15	" " 0X25m5	5

Permissible Variations ± 10 per cent.

Table 6

Grade of Alloy	Elongation, per cent, minimum	Specific Electrical Resistance		Permissible Variations
		For Strip Thickness, mm	Specific Resistance at 20°C, ohms sq. mm. m	
N15H60	22	up to 0.8	1.09	- 0.05
		from 0.9 to 3.0 incl.	1.11	
		over 3.0	1.12	
N20H80	20	up to 0.8	1.08	- 0.09
N20H80T		from 0.8 to 3.0 incl.	1.10	
		over 3.0	1.11	
N20H80T3	30		1.27	- 0.09
N13m4	18		1.26	- 0.08
1X17m5	12		1.30	- 0.10
0X17m5	15			
1X25m5	10		1.40	- 0.10
0X25m5	12			

Each lot of strip consists of metal of the same heat and of strip of the same dimensions.

Strip manufactured by flattening of round wire is furnished wound on spools, while strip of 0.2 mm and over thickness is furnished coiled in rolls and consists of a single length of strip.

Flattened-wire strip is shipped wrapped in moisture-proof paper and packed in wooden boxes. Rolls of cold-rolled strip are shipped wrapped in sacking or bast matting. Hot-rolled strip is shipped without wrapping. The weight of a bundle or package of strip shall not exceed 80 kg.

Each roll or spool of strip is furnished with an attached tag marked with the grade designation and ohmic resistance per linear metre of the strip.

Every lot of strip shipped from the Works is accompanied by a certificate.

Wire is manufactured to the requirements of the USSR Standard GOST 2238-53 and is cold-drawn to diameters of from 0.10 to 10 mm inclusive, and hot-rolled to diameters of from 6 to 10 mm inclusive.

Cold-drawn wire is furnished heat treated.

The wire is furnished with a smooth, even finish; only inconsiderable scratches and slight traces of the drawing, to a depth not exceeding one half of the permissible variation in diameter are allowed on the surface of the wire. Out-of-roundness (ovality) is guaranteed not to exceed, for cold-drawn wire, one half of the permissible variation in diameter and, for hot-rolled wire, the total permissible variation in diameter.

As to condition and appearance of the surface, hot-rolled wire ("H") shall have a black scaly surface, while cold-drawn wire is available with a dark, oxidized surface, with a film acquired during annealing ("O"), a tempered-coloured surface ("H"), a clean metallic surface free from oxide ("M"), and with a bright surface free from oxide and traces of the lubricant used during drawing — bright finished for enameling. Wire intended for enameling is available only in alloys grades X20H80 or X15H60, and in diameters of from 0.01 to 0.1 mm. The presence of titanium in wire of diameter under 0.2 mm is not allowed; in wire ranging from 0.2 mm and over in diameter, the titanium content shall not exceed 0.1%.

The wire, when manufactured, is tested for elongation and ability to withstand winding.

Wire in diameters ranging from 0.01 to 0.060 mm shall have a per cent elongation which conforms to the corresponding value prescribed in Table 7.

After being wound five times around a mandrel of required diameter, wire in diameters of from 0.7 to 6 mm shall not break or display signs of lamination.

Elongation and winding tests are not conducted on wires over 6 mm in diameter.

Hot-rolled wire is produced in diameters of 6, 7, 8, 9 and 10 mm, with a permissible variation in diameter equal to ± 0.5 mm.

Cold-drawn wire is furnished in the diameters and weights per single length of wire listed in Table 8.

„Low-weight“ lengths of wire are permissible in any lot to only 25 per cent, by weight, of the lot.

Grade X1304 wire is furnished in diameters not less than 0.2 mm; while wire of grades X20H80T3, 0X1705 and 0X2505 are furnished in diameters not less than 0.3 mm. Grades 1X1705 and 1X2505 are furnished only hot-rolled.

Table 7

Diameters of Wire, mm	Minimum Elongation, per cent		Diameter of Wire, mm	Minimum Elongation, per cent	
	Wire for all Applications other than Enameling	Wire for Enameling		Wire for all Applications other than Enameling	Wire for Enameling
0.010 — 0.015	6.0	16.0	0.080 — 0.090	14.0	16.0
0.020 — 0.040	8.0	12.0	0.10 — 0.40	16.0	18.0
0.045 — 0.070	10.0	14.0	0.45 — 0.60	18.0	



Table B

Diameter of Wire	Permissible Variations	Weight of one length of Wire, by minimum			
		Wire for all Applications other than Enamaling		Wire for Enamaling	
		Normal Weight	Low Weight	Normal Weight	Low Weight
0.010; 0.015	- 0.003	0.001	0.0005	0.0020	0.0010
0.020; 0.035		0.003	0.0015	0.010	0.004
0.030; 0.040		0.010	0.005	0.030	0.010
0.050; 0.060; 0.070	- 0.005	0.020	0.010	0.075	0.025
0.080; 0.090		0.050	0.025	0.150	0.075
1.10; 0.11; 0.12	- 0.01	0.100	0.050	0.300	0.150
0.13; 0.14; 0.15		0.125	0.065	0.500	0.250
0.16; 0.17; 0.18		0.150	0.075	0.750	0.350
0.19; 0.20					
0.22; 0.25; 0.28	0.01 0.02	0.200	0.100	1.500	0.750
0.30					
0.35; 0.40	0.02 0.03	0.300	0.150	3.000	1.500
0.45; 0.50; 0.55		0.500	0.250		
0.60					
0.70; 0.80	- 0.03	0.500	0.250		
0.90		1.500	0.750		
1.00; 1.10; 1.20	- 0.05	1.500	0.750		
1.40; 1.60; 1.80		2.500	1.250		
2.00; 2.20; 2.50		4.000	2.000		
2.80; 3.00		6.000	3.000		
3.05	- 0.06	6.000	3.000		
4.0; 4.5; 5.0; 5.5		10.000	5.000		
6.0; 6.5; 7.0		20.000	10.000		
7.5	- 0.10				
8.0; 8.5; 9.0		30.000	15.000		
9.5					
10.0		40.000	20.000		

On request of the purchaser wire in diameter of from 0.10 to 0.20 mm may be furnished held to a permissible variation in diameter of ± 0.005 mm. Wire intended for enameling and of diameter ranging from 0.22 to 0.30 mm is furnished held to a permissible variation in diameter of ± 0.01 mm, while wire of diameter ranging from 0.35 to 0.10 mm is furnished held to a permissible variation in diameter of ± 0.01 to ± 0.02 mm.

The guaranteed values of specific electrical resistance, depending upon the diameter of the wire and the grade of alloy used, are listed in Table 9.

On mutual agreement between the parties concerned, it is allowable to ship wire with a specific electrical resistance higher in value than the prescribed upper limit, under condition that the difference in specific electrical resistance of the wire in the lot, will not exceed the difference in prescribed range of values of resistance.

Wire is shipped in lots consisting of wire of one dimensions, of the same grade of alloy and of wire which has been subjected to an identical processing.

The wire 0.5 mm and under in diameter is shipped wound on spools, while the wire over 0.5 mm in diameter is shipped in coils.

It shall be allowable to wind several lengths of wire on one spool, but the number of lengths shall not exceed five. Wire intended for enameling is to be wound on the spool in only one length.

Wire of diameter 0.10 mm and under, and of grades X13u4, 1X17u5, 0X17u5, 1X25u5 and 0X25u5, for protection against corrosion, is to be covered with a continuous, clean, neutral coating which does not cause the separate turns of wire to stick to each other. Spools or coils of wire, 0.14 mm and under in diameter, are to be wrapped in moisture-proof paper and packed in completely closed wooden boxes. Wire of diameter from 1.6 to 3.0 mm, for shipment, is to be wrapped with packing cloth.

Table 9

Grade of Alloy	Diameter of Wire, mm	Specific Electrical Resistance Ohms, sq. mm/m	
		Limit Values	Design Value
X15H60	0.01 to 0.02 incl.	1.02 - 1.15	1.09
	over 0.20 to 0.45 incl.	1.04 - 1.17	1.11
	over 0.45 to 10	1.05 - 1.18	1.12
X20H80	0.01 to 0.20 incl.	1.02 - 1.12	1.07
	over 0.20 to 0.45 incl.	1.04 - 1.14	1.09
	over 0.45 to 3.00 incl.	1.05 - 1.15	1.10
	over 3.00 to 10	1.07 - 1.17	1.12
X20H80T3	from 0.3 to 10.0	1.18 - 1.36	1.27
X13u4	.. 0.2 to 10.0	1.18 - 1.34	1.26
1X17u5	.. 6.0 to 10.0	1.20 - 1.40	1.30
0X17u5	.. 0.3 to 10.0	1.20 - 1.40	1.30
1X25u5	.. 6.0 to 10.0	1.30 - 1.50	1.40
0X25u5	.. 0.3 to 10.0	1.30 - 1.50	1.40

Wire in diameters ranging from 3.5 mm and over is to be shipped without packing.

The weight of each package or bundle of wire shall not exceed 80 kg.

A tag is to be attached to each coil or spool shipped from the Works; it shall bear the following information: the diameter of the wire, the date of manufacture, and the grade designation of the wire.

On request of the purchaser, on every spool of wire 0.5 mm and under in diameter, the tag shall also bear the value of the specific electrical resistance of the wire wound on the spool.

Every lot of wire shipped from the Works is to be accompanied by a certificate.



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